# Consolidation of Egress Time Change Items (TCI)
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In 1996, RAND and the AFLMA initiated a joint study, Leveraging Logistics to Enhance the Effectiveness of Rapid Air Expeditionary Forces (AEF). Over the course of this study, the AFLMA's focus was on deploying unit preparations. The AFLMA looked at three scheduled maintenance activities for the F-15D/E's: the number of phase inspections accomplished, the number of engines changed, and the number of egress time change items (TCI) replaced in preparation for a deployment. An area of concern was the significant spike in the number of egress TCIs that were being replaced on the aircraft scheduled for deployment. Three alternatives were looked at for the replacement of egress TCIs: a 36-month maintenance cycle which consolidates egress TCIs with the 36-month seat inspection, a 30-month maintenance cycle which requires the 36-month seat inspection to be done early, but is in sync with a 15-month AEF concept of operations, and a 12-month "look-out" policy which affords units more flexibility when scheduling/replacing egress TCIs. Both the 36-month and 30-month maintenance cycles result in increased parts cost due to an increase in the frequency of part replacements, a decrease in maintenance man-hours due to a decrease in the frequency of seat removals, and a possible decrease in aircraft downtime by eliminating any downtime specifically for egress TCI maintenance. The 12-month "look-out" policy is an extension of current procedures, allowing schedulers to look out further for any maintenance coming due. This policy will cause parts to be replaced ahead of schedule, resulting in an increased parts cost, though the increase is much less than a 30-month or a 36-month maintenance cycle. Under this policy there is no reduction in the number of seat removals, however, there is the possibility for a decrease in egress TCI maintenance events and aircraft downtime.

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# EXECUTIVE SUMMARY

## BACKGROUND STATEMENT

In 1996, RAND and the AFLMA conducted a joint study, *Leveraging Logistics to Enhance the Effectiveness of Air Expeditionary Forces (AEF)*. The AFLMA focused on deploying unit preparations. During the data collection process, it became apparent there was a significant increase in the number of egress time change items (TCI) being replaced on F-15E aircraft prior to deploying. Using an F-15D/E egress TCI schedule, our preliminary analysis indicated that over a 20 year period, an F-15D/E aircraft would have anywhere from 24 to 170 egress TCI maintenance events performed on it. Our preliminary analysis also indicated that a possible reduction in the number of egress TCI maintenance events and downtime could be achieved by consolidating the egress TCIs. We explored the possibility of consolidating egress TCIs for replacement based on a 42-month maintenance cycle. This would decrease the number of egress maintenance events to 6, over 20 years. As our research developed, we discovered the ACES II seat has a mandatory 36-month inspection. This inspection involves complete disassembly/ reassembly of the seat—opportune time to replace egress TCIs. The 36-month inspection was a major factor in our considering a 36-month maintenance cycle versus the preliminary 42-month maintenance cycle. Further, we considered two other alternatives: a 30-month maintenance cycle, which lends itself well to a multiple of a 15-month AEF rotation, and a 12-month "look-out" policy (which is an extension of the current policy) that allows units to forecast, schedule, and replace the egress TCI parts up to 12-months in advance.

## PROBLEM STATEMENT:

HQ USAF/ILM tasked the AFLMA to determine if a 36-month maintenance cycle for all egress TCIs were implemented, what would the impact be on parts cost, maintenance events/aircraft downtime and maintenance man-hours.

## OBJECTIVES:

1. Determine the parts cost per F-15D/E aircraft to implement a 36-month maintenance cycle, a 30-month maintenance cycle, and a 12-month "look-out" policy for egress TCIs.
2. Determine the proposals' impact and any cost savings for egress TCI maintenance events/aircraft downtime, and maintenance man-hours.
3. Evaluate the impact of revised egress TCI intervals on AEF deployment operations.

## ANALYSIS/RESULTS:

The AEF requirement to deploy quickly and employ immediately places a huge burden on home units. Preparing a unit for deployment involves selecting which aircraft to send and ensuring the selected aircraft are prepared to support sustained operations at a forward location. This preparation often includes the early accomplishment of routine maintenance and inspections on a tight timeline to ensure maximum aircraft availability. For the egress system, it is imperative that TCIs projected for change during the deployment are replaced prior to deploying because of problems encountered with customs and delivering the explosive parts for the ejection seat to forward locations.

Additionally, the Aerospace Ground Equipment (AGE) and infrastructure required to perform egress TCI maintenance at deployed locations may not be available. In pursuit of more efficient procedures, we looked at three proposals for replacing F-15D/E egress TCIs: a 36-month maintenance cycle, which consolidates egress TCIs with the current 36-month ACES II seat inspection; a 30-month maintenance cycle, which requires the current 36-month ACES II seat inspection to be done early, but is in sync with a 15-month AEF concept of operations; and a 12-month "look-out" policy, which affords units more flexibility when scheduling/replacing egress TCIs. Both the 36-month and 30-month maintenance cycles result in increased parts cost due to an increase in the frequency of parts replacement, but they also result in decreased maintenance man-hours (and possibly aircraft downtime) due to a decrease in the frequency of seat removals and elimination of any downtime that would be specifically for egress TCI maintenance. The 12-month "look-out" policy is an extension of current procedures, allowing schedulers to "look-out" further for any maintenance actions coming due. Although this policy does not reduce the number of seat removals, there is the possibility for a decrease in egress TCI maintenance events and aircraft downtime (depending upon the management of the TCI program). However, parts will be replaced ahead of schedule, resulting in increased parts cost, though the increase is much less than with a 30-month or a 36-month maintenance cycle.

## CONCLUSIONS

Based upon our research and analysis, we concluded that the current egress TCI policies and procedures for the F-15D/E aircraft are working, as evidenced by the proven ability of units to deploy and sustain operations. However, due to the unique challenges and requirements that an AEF presents, current policies and procedures need to be adjusted accordingly to better meet the AEF taskings. Making adjustments to the current policies and procedures doesn't come without cost and although there is an increase in parts cost for both the proposed 36-month or 30-month maintenance cycles and the 12-month "look-out" policy, the intangible benefits gained may outweigh the increase in parts cost:

1. More efficient deployment preparation for expeditionary operations (i.e. a reduction in the number of aircraft requiring off-schedule egress TCI maintenance).
2. Fewer seat removals result in reduced risk of accidental or additional wear and tear on the aircraft or associated systems (see Appendix D).
3. Reduction in maintenance man-hours and possible aircraft downtime (increased aircraft availability) due to consolidation of egress TCI maintenance actions.
4. Maintenance-free windows for egress TCI maintenance for the duration of an AEF deployment.
5. The ACES II seat inspection due date would be used for tracking purposes, eliminating tracking numerous individual item due dates.
6. More predictable maintenance cycles will enable units and the Air Logistic Centers (ALC) to better forecast for parts requirements.

## RECOMMENDATIONS:

### SHORT TERM:

1. Implement a 12-month "look-out" policy for F-15D/E egress TCIs. Incorporate previously recommended Technical Order (T.O.) changes, AF XO/IL Offsite Action Item #8, 25 August 1997, which identified/proposed time interval changes to current policies (see Appendix A). (OPR: HQ USAF/ILM)

**LONG TERM:**

1. Consider establishing a transition team to implement either a 36-month or 30-month maintenance cycle for F-15D/E egress TCIs. **(OPR: HQ USAF/ILM)**

2. Explore the feasibility of adopting the same maintenance cycle for other aircraft with the ACES II seat. **(OPR: HQ USAF/ILM)**

3. Incorporate a change/capability to track egress TCIs in the Integrated Maintenance Data System (IMDS) based on the ACESS II seat inspection due date in addition to the date of installation (DOI) and date of manufacture (DOM) of each TCI. **(OPRs: HQ USAF/ILM and IMDS/SPO)**

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# CHAPTER 1

# INTRODUCTION

## BACKGROUND

This study was sponsored by HQ USAF/ILM and is a follow-on to the joint RAND/AFLMA study, *Leveraging Logistics to Enhance the Effectiveness of Air Expeditionary Forces (AEF).* Over the course of this study, the AFLMA's focus was on deploying unit preparations. We looked at three scheduled maintenance activities for the F-15D/E's: the number of phase inspections accomplished, the number of engines changed, and the number of egress time change items (TCI) replaced in preparation for a deployment. An area of concern was the significant "spike" in the number of egress TCIs that were being replaced on the aircraft scheduled for deployment. Our preliminary analysis showed that, depending upon how the TCIs are replaced, as single items or as a combination of items, an F-15D/E would have between 24 and 170 egress TCI maintenance events performed on it over a 20 year period. This is a significant amount of maintenance, so we researched the possibility for a common frequency among the TCIs. We found that 42-months was common to most items, with the exception of three items that have 36-month frequencies. Based on this, we determined that if egress TCIs were consolidated into a 42-month maintenance cycle, an F-15D/E would have 6 egress TCI maintenance events performed over 20 years. We then factored in the TCIs with the 36-month frequencies (7 egress TCI maintenance events over 20 years) and determined that an F-15D/E would have a total of 13 egress TCI maintenance events performed over 20 years. NOTE: if the items with the 36-month frequencies could be increased to 42-months, then the number of egress TCI maintenance events would decrease to 6 over a 20 year period. This would be a significant reduction in the number of egress TCI maintenance events and possibly aircraft downtime.

As our research developed, we discovered there is a mandatory 36-month ACES II seat inspection, which involves complete disassembly/reassembly of the seat--an opportune time to replace egress TCIs. This 36-month seat inspection was a major factor in our considering a 36-month maintenance cycle versus the preliminary 42-month maintenance cycle. Therefore, by consolidating TCIs into a 36-month maintenance cycle, an F-15D/E would require 7 egress TCI maintenance events to be performed over 20 years.

We also considered two other alternatives. First, a 30-month maintenance cycle, which lends itself well to a multiple of a 15-month AEF cycle. Second, a 12-month "look-out" policy, an extension of the current policy, that allows units to forecast, schedule, and replace parts up to 12-months in advance.

## PROBLEM STATEMENT

HQ USAF/ILM tasked the AFLMA to determine if a 36-month maintenance cycle for all egress TCIs were implemented, what would the impact be on parts cost, maintenance events/aircraft downtime, and maintenance man-hours.

## STUDY OBJECTIVES

The study focused on three main objectives:

1. Determine the parts cost per F-15D/E aircraft to implement a 36-month maintenance cycle, a 30-month maintenance cycle, and a 12-month "look-out" policy for egress TCIs.
2. Determine the proposals' impact and any cost savings for egress TCI maintenance events/aircraft downtime, and maintenance man-hours.
3. Evaluate the impact of revised egress TCI intervals on AEF deployment operations.

## ASSUMPTIONS

For the purpose of this study the following assumptions were made:

1. We used only the F-15D and F-15E aircraft in our research because the ejection seats are identical with the exception of the SMDC (Shielded Mild Detonation Cord) line configurations.
2. We looked at egress TCIs only and did not include any life support or emergency equipment that may also be on the ejection seat.
3. Study focused on egress scheduled maintenance (two seat removals per year) actions only and did not take into consideration any unscheduled maintenance actions that may occur.
4. We used the AEF concept of operations from the EAF/AEF Analytical Conference, November 98, where every unit is assigned to a specific AEF, with a predictable deployment vulnerability schedule (15-month cycle).
5. We did not include the Shielded Mild Detonation Cord (SMDC) Line Sets (Work Unit Code = 97AAH) in our analysis as the set is replaced during programmed depot maintenance.

## CONSTRAINTS

1. One of our objectives was to determine the impact on aircraft downtime and any associated cost savings that would be gained by consolidating egress TCIs. However, we were unable to accurately measure this. In order to do this we needed to map out the egress process step-by-step, beginning when the aircraft is "taken down" for scheduled maintenance, including each maintenance action (defuel, dearm, tow, etc.) and any "waiting times" in-between, and ending when the aircraft is released back to the squadron. Our research showed that IAW Air Force policies and procedures, TCIs should be considered for replacement in conjunction with other scheduled maintenance. However, after interviewing maintenance personnel, we learned this is not being done at all bases—often deployments are dictating when TCIs are getting replaced and not necessarily other scheduled maintenance. With this in mind, we attempted to map out the process, but due to variability in the egress process among the bases and insufficient/unavailable data/information showing the "waiting times" between each step, we were unable to complete this objective.

2. The cost estimates in this study are based on assumptions made/listed throughout our analysis.

Because of the amount of variability in the egress TCI maintenance process among the bases we interviewed and visited, the estimates in the study do not capture the variability of the entire process. However, the results do provide a rough idea of the magnitude of the quantifiable costs and benefits of the proposals presented in this study.

# CHAPTER 2

# DISCUSSION AND ANALYSIS

## OVERVIEW

While the deployment preparation process is generally chaotic for everyone involved, preparing ejection seats for deployments has been an identified stumbling block. Most other maintenance and inspections can be accomplished in theater, however, all egress TCI maintenance must be performed prior to deployment due to problems with customs and getting egress parts to forward locations. In addition to customs problems, the Aerospace Ground Equipment (AGE) and infrastructure required to perform egress TCI replacements at deployed locations are not always available. Also, scheduled maintenance should be minimized while deployed so resources can be directed towards accomplishing the primary mission of flying wartime sorties and ensuring aircraft are not unduly grounded. In the months and weeks before deployment, it is common for a unit to perform "predeployment prep" on 100% of their Primary Assigned Aircraft (PAA), to include replacing any egress TCIs with a shelf/ service life expiring while the unit is to be deployed.

## CURRENT TCI POLICIES AND PROCEDURES

We interviewed maintenance personnel extensively, through site visits and conference calls, concerning current egress TCI policies and procedures:

1. Egress TCIs have a limited shelf/service life and must be replaced prior to the expiration date. If a part exceeds its expiration date, the aircraft is grounded. In terms of parts cost, the most efficient replacement policy is to use each part for its entire shelf/service life. Therefore, when the shelf/service life of the TCI is nearing expiration, the aircraft should be taken off the flying schedule and the part replaced. However, aircraft downtime is an important consideration, and it is more practical to perform egress TCI replacements when an aircraft is already down for some other scheduled maintenance action. (IAW T.O. 00-20-1, Aerospace Equipment Maintenance General Policies and Procedures, maintenance personnel should "consider TCIs due for replacement at the hourly postflight, home station check, phased, periodic, minor or major isochronal, scheduled PDM, etc. nearest to the replacement date.") With this in mind, as the schedulers are planning to remove an aircraft from the flying schedule for scheduled maintenance, such as a phase inspection, they will also look for any other maintenance (egress TCIs, delayed discrepancies, etc.) that can be accomplished while the aircraft is down.

    a. Deployment preparation process: Using a Planning Requirements listing from the Core Automated Maintenance System (CAMS), which lists the maintenance requirements and forecasts the inspections and time changes coming due within a specified period of time (generally 6-months), maintenance schedulers will determine what maintenance needs to be accomplished prior to the deployment.

Note: IAW Air Force policy and procedures, even though schedulers are looking out 6-months, there are limits as to when items can be replaced due to restrictions on the parts forecasting and ordering processes. IAW Air Force 21-101, Maintenance Management of Aircraft, "Order all items requiring time change up to 60 days before the required month. Order munitions items 60 days before the beginning of the month required" (see Appendix A).

b. The maintenance scheduler then coordinates with egress personnel to determine if they can support replacing the TCIs. If the egress shop cannot support egress maintenance to coincide with other scheduled maintenance, the aircraft will be scheduled for maintenance at a later date, causing additional aircraft downtime. If the egress shop can support replacing the items, Munitions Operations (Supply) is notified of the pending maintenance action, the date the action is to be completed, and the parts needed. Munitions Operations (Supply) then ensures the requested parts are available. Prior to the aircraft being placed in scheduled maintenance, an AF Form 2005 "Issue/Turn-in Request" is sent to Munitions Operations (Supply) requesting issue of the part(s). Once the part(s)is replaced, it is turned in to Munitions Operations (Inspections) for inspection. Inspection personnel assign each part a condition code, depending on how much service/shelf life remains. The assigned condition code indicates disposition of the part: disposed of, returned to ALC, or put back on the shelf for possible reissue.

IMPORTANT: Most egress TCI maintenance requires the ejection seat to be removed from the aircraft before the maintenance is performed. It often takes more time to remove the seat for maintenance than it takes to replace the part. Removing an ejection seat requires facilities (hangar) to be available and includes the time spent waiting for the necessary crane and crew, as well as the man-hours required for the seat removal. In addition, due to crowded cockpit conditions, there is a risk of causing damage to the aircraft and other systems whenever an ejection seat is removed from an aircraft (see Appendix D). For these reasons, everyone involved in egress maintenance stresses that seats should be removed as infrequently as possible. The current policy of balancing replacement costs against the desire to combine egress TCI with other scheduled maintenance, while at the same time trying to limit the number of seat removals, results in every seat visiting the egress shop on an average of twice per year for scheduled maintenance.

## METHODOLOGY

1. We obtained F-15D and F-15E egress TCI schedules that listed each egress item, the service life (date of installation [DOI]), the shelf life (date of manufacture [DOM]), national stock numbers (NSN), and part numbers.

2. Next, we used Federal Logistics (FEDLOG) on compact disk to obtain prices for each NSN and to determine which NSN was the "Master NSN".

3. We obtained, from subject matter experts, estimated crew size and task duration for each TCI item and the seat removal process.

4. We reviewed the existing policies and procedures for egress TCIs. We reviewed Air Force Instructions, Technical Orders, and spoke to subject matter experts to determine current methods and policies for replacing egress TCIs.

5. Finally, we used the information gathered to determine the impact on parts cost, the impact on the number of maintenance events/aircraft downtime, and the impact on maintenance man-hours that would result from a reduction in maintenance events and aircraft downtime. We compared the current egress TCI procedures to a 36-month maintenance cycle, a 30-month maintenance cycle, and a 12-month "look-out" policy.

## PROPOSALS

We began our analysis by developing charts that depicted the flow of three egress TCI maintenance schedules. Figure 1 illustrates the egress TCI maintenance schedule under current policies and procedures. Figures 2 and 3 illustrate the egress TCI maintenance schedule under a 36-month maintenance cycle and a 30-month maintenance cycle. Because the 12-month "look-out" policy is an extension of the current policies and procedures, we did not chart that data.

## CURRENT POLICY

Consider the egress TCI maintenance schedule of a sample unit with 24 PAA and use the following assumptions: every aircraft in the unit has scheduled egress TCI maintenance once every six months and the workload is balanced such that the egress shop is only scheduled to work on seats from one tail number at a time. Figure 1 represents a feasible schedule of the current egress TCI maintenance requirements for the 24 PAA over a period of 36 months. A "+" sign indicates when each of the 24 PAA would be scheduled for egress TCI maintenance. A depiction of the new 15-month AEF cycle is overlaid at the top of the chart to show how egress TCI maintenance lines up with respect to the deployment vulnerability window for the unit. Under the EAF concept of operations from the EAF/AEF Analytical Conference, November 1998, every unit will be assigned to an AEF, which will have a predictable schedule for deployment vulnerability. The 15-month cycle consists of approximately 9-months of "normal" operations, 3-months of deployment preparation, a 3-month deployment "on-call" window, and a few weeks of stand-down time. In Figure 1, a circle is drawn around all of the "+" signs that correspond to egress TCI maintenance scheduled to occur during the unit's "on call" period. This egress TCI maintenance must be accomplished off-schedule and prior to deployment to ensure that no aircraft is grounded in theater due to the inability to perform egress TCI maintenance.

The circled "+" signs in Figure 1 illustrate that 12 of the 24 PAA at the sample unit would require egress TCI maintenance off-schedule to prepare the unit for deployment. Recall that for this example it was assumed that the egress workload was well balanced and the egress shop is scheduled to work on seats from one tail number at a time. In a more realistic scenario, the egress workload would be more erratic, leading to more off-schedule egress preparation for deployment. The results of this example support what has been observed in the field and serves to illustrate the deployment preparation difficulties that are the focus of this study.

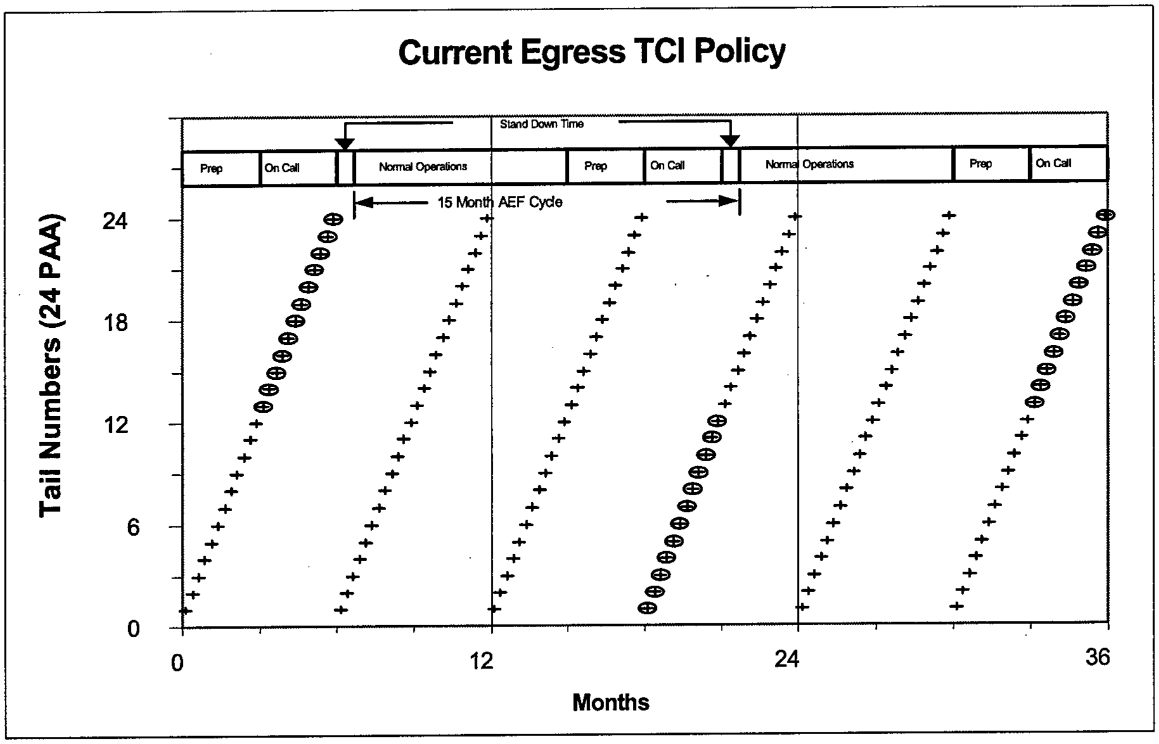


**Figure 1 Current Egress TCI Policy**

## 36-MONTH MAINTENANCE CYCLE

Our first proposal to the current egress TCI maintenance policies and procedures involves consolidating all egress TCI maintenance into one recurring maintenance cycle. Since there is already a 36-month ACES II seat inspection (when the seat is completely stripped down and parts are easy to replace) it is practical to consider scheduling the egress TCI maintenance on a 36-month maintenance cycle. The 36-month maintenance cycle would look at the remaining service/shelf life of every egress TCI at the 36-month ACES II seat inspection and replace every part that would expire before the next seat inspection. With this policy, a seat is only removed from an aircraft once every 3 years for scheduled maintenance. This policy results in increased parts cost due to an increase in the frequency of part replacements, but it also results in a decrease in maintenance man-hours (and possibly aircraft downtime) due to a decrease in the frequency of seat removals and elimination of any downtime specifically for egress. The effect on AEF preparation is a significant reduction in the number of aircraft that will require off-schedule egress TCI maintenance. The chart in Figure 2 illustrates this effect.

The chart in Figure 2 uses the same 24 PAA sample unit (as in Figure 1) and makes the same assumption: that the egress workload is balanced such that the egress shop is only scheduled to work on seats from one tail number at a time. A "-" (dash) indicates when each of the 24 PAA would be scheduled for egress TCI maintenance and the circled "-"indicate egress TCI maintenance that must be accomplished off-schedule in order to accommodate the AEF "on call" window.

Figure 2 shows that a 36-month maintenance cycle reduces the number of aircraft that require off-schedule egress TCI maintenance from 12 (current policy) to 2 of the 24 PAA.

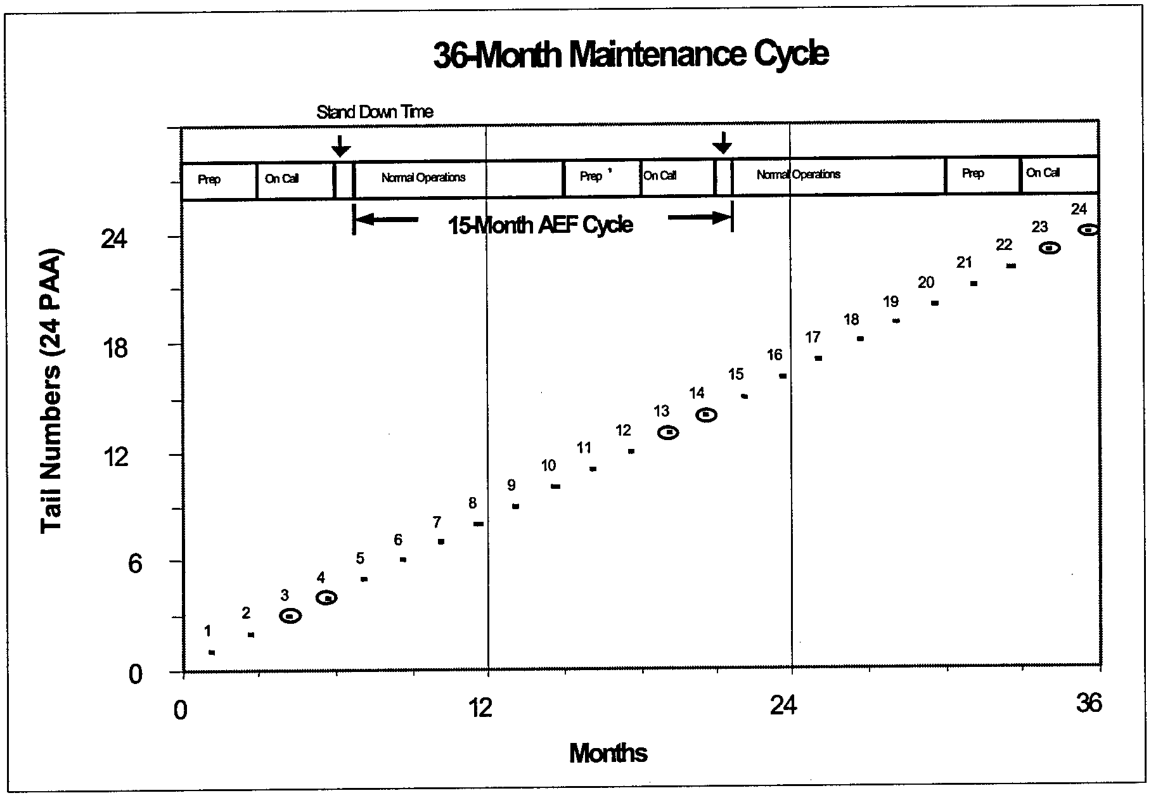


**Figure 2 36-Month Maintenance Cycle**

## 30-MONTH MAINTENANCE CYCLE

The second egress TCI maintenance proposal is similar to the 36-month maintenance cycle except it is based on a 30-month maintenance cycle. This policy, however, requires the current 36-month ACES II seat inspections to be performed 6-months early. Like the 36-month maintenance cycle, the 30-month maintenance cycle results in an increase in parts cost, but a decrease in maintenance man-hours and possibly aircraft downtime. The difference is that in exchange for an increase in the frequency of seat inspections, the 30-month maintenance cycle is better suited for a 15-month AEF cycle. Any recurring egress maintenance that is originally scheduled in the "normal operations" or in the "prep" phase of the AEF cycle will always occur at the same point in future iterations of a 15-month AEF cycle. Assuming that a unit's AEF cycle will always be on track, it is possible to set up an egress maintenance schedule such that it should never be necessary to perform off-schedule egress TCI maintenance to prepare for an AEF deployment. The chart in Figure 3 illustrates this concept. A "-" (dash) indicates when each of the 24 PAA would be scheduled for egress TCI maintenance.

Note: This proposed maintenance cycle is dependent upon a 15-month AEF cycle. Should the cycle change (i.e. 12-month or 18-month AEF cycle), this 30-month process would clump together egress TCI maintenance events that could otherwise be more evenly distributed.

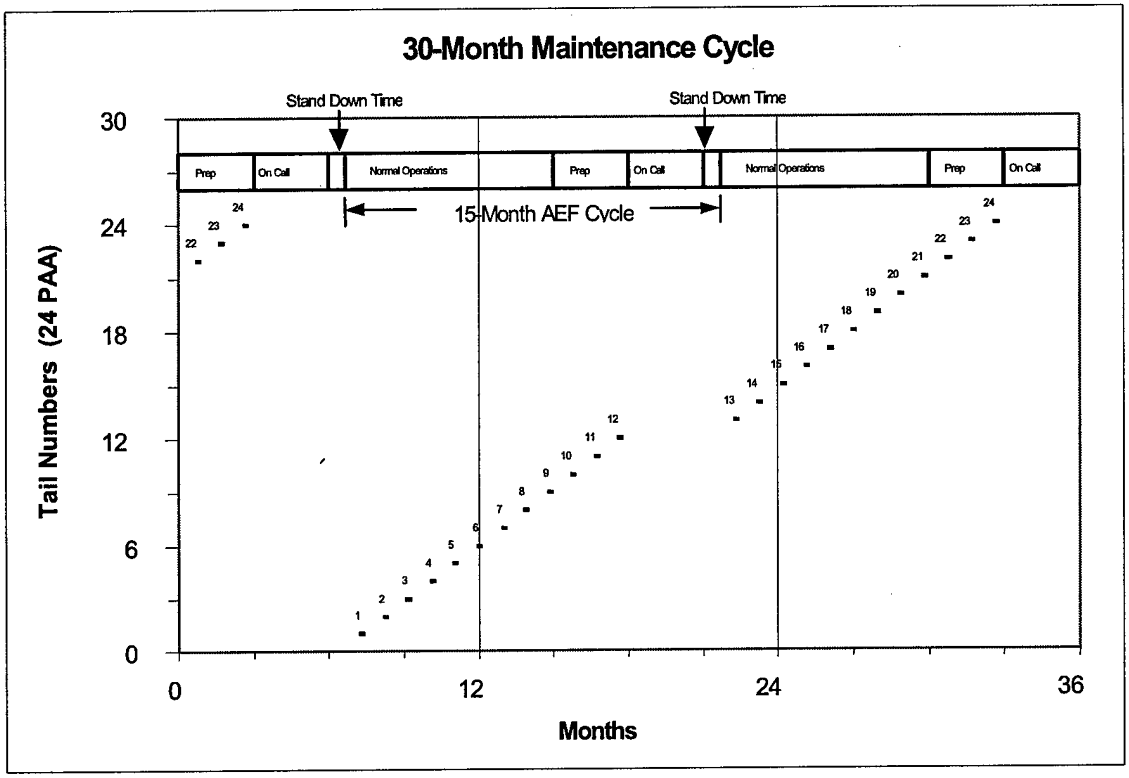


**Figure 3 30-Month Maintenance Cycle**

## 12-MONTH "LOOK-OUT" POLICY

Both the 36-month and the 30-month maintenance cycles call for an increase in the frequency of egress TCI replacements. This increased replacement frequency leads to a direct increase in parts cost. For this reason, this study also considered a third policy alternative that addresses the deployment preparation issue with a smaller increase in parts cost. This policy proposal, the 12-month "look-out" policy, is an extension of the current egress TCI maintenance policy and offers more efficient deployment preparation, but does not reduce the number of seat removals. Under the current egress TCI policy, maintenance schedulers look for egress items that would expire within 6-months of any scheduled maintenance action. If schedulers could order parts further in advance and replace parts sooner, the system would be more flexible and egress preparations could be made further in advance of deployments. However, with schedulers looking further out, parts will be replaced ahead of the programmed change and more service/shelf life is lost. This loss of service/shelf life represents an increase in parts cost, but the increased cost is much less than with a 36-month or a 30-month maintenance cycle.

## IMPACT OF PROPOSALS

There are some quantifiable costs and benefits that can be measured in this study: the effects of a policy proposal on seat removals, parts cost, and egress maintenance man-hours. The first of these quantifiable effects, seat removal reduction, is the easiest to demonstrate.

**SEAT REMOVALS**

There are many benefits of removing ejection seats from aircraft less frequently, but only one is easy to quantify—the direct reduction in egress maintenance man-hours. The following assumptions were used to analyze the impact of fewer seat removals on egress maintenance man-hours:

1. Each aircraft has two seats.
2. Each seat is currently removed approximately twice a year for scheduled maintenance.
3. A crew size of 3 is required for a seat removal.
4. Each seat removal takes an average of 2.75 hours.

Based on these assumptions, Table 1 reflects the average number of seat removals and estimated man-hour, per aircraft, per year for the current egress TCI policy as compared to each of the three proposals. It illustrates that a reduction in the number of seat removals for scheduled egress TCI maintenance leads to a direct reduction in maintenance man-hours. NOTE: The 36-month and 30-month maintenance cycle information has been converted to yearly averages so that they can be compared with the current policy and the 12-month "look-out" proposal.

| | Current | 12-Month | 30-Month | 36-Month |
|---|---|---|---|---|
| Avg. number of seat removals | 4 | 4 | 0.80 | 0.67 |
| Est. annual man-hours for seat removal | 33.00 | 33.00 | 6.60 | 5.50 |
| Change in annual man-hours from current procedure | N/A | 0.00 | -26.40 | -27.50 |

**Table 1 - AVERAGE NUMBER YEARLY SEAT REMOVALS AND MAN-HOURS**

**AVERAGE ANNUAL PARTS COST AND REPLACEMENT MAN-HOURS**

Two other quantifiable costs that can be measured are the annual parts cost and part replacement man-hours. All three proposals: the 36-month maintenance cycle, the 30-month maintenance cycle, and the 12-month "look-out" policy, require parts to be replaced more frequently than the current policy. To accurately estimate any increase or reduction in the parts costs and replacement man-hours, we considered the following:

1. Unique service lives: Since each part has a unique service life, the analysis was conducted on a part-by-part basis. For a given egress TCI, there may be multiple national stock numbers (NSN) representing the same part manufactured by different vendors. Even though these multiple NSNs are interchangeable, they may have significantly different costs and service lives. To account for the differences in costs, service life and vendor, the annual cost and man-hour

estimates for a given TCI were computed as a weighted sum of the cost and man-hour estimates for each of the interchangeable NSNs (see formulas in Appendix C).

2. Parts distribution: To determine the distribution of parts, available by NSN through supply, we considered various methods for obtaining historical data. These methods included the purchase records from the Air Logistics Center (ALC), the expenditure records from the Combat Ammunition System (CAS), and the disposal records for parts with expired service/shelf lives. However, each of these methods has the same problem: past availability does not accurately reflect future availability—largely due to the part requirements being contracted to different vendors. Therefore, there is the potential for historically estimated distributions to be seriously flawed. For this reason, this analysis makes the following simplifying assumptions instead of attempting to estimate historical distributions:

   a. If an egress TCI has a single NSN designated as the master NSN, the $P_{i,j}$ (probability that a demand for TCI *i* will be satisfied with a part manufactured by vendor *j*) for the master NSN is set to 100% and the $P_{i,j}$ for each substitute NSN is set to 0%.
   b. If an egress TCI has multiple NSNs designated as the master NSNs, the $P_{i,j}$ are set to give each master NSN equal weight and the $P_{i,j}$ for each substitute NSN is set to 0%.
   c. If an egress TCI has no NSN designated as the master NSN, the $P_{i,j}$ are set to give each interchangeable NSN equal weight.

3. The maximum service life expectancy (from time of manufacture to time of replacement) for a given TCI:

   a. There are two life expectancies associated with each NSN that we used:
      1. Shelf life, in years, from date of manufacture (DOM).
      2. Service life, in years, from date of installation (DOI).

   b. The item managers and equipment specialists at the ALC noted that parts have an average of 21-months*, or 1.75 years, inventory holding time (when parts are "on the shelf" at depot or in transit) before being issued to a unit. If the shelf life is greater than the service life, we assume the inventory holding time does not affect the amount of usable service life for the part. However, if the shelf life and service life are the same, we need to account for the inventory holding time. We do this by reducing the service life by 21-months, the average inventory holding time. With this is mind, we used the following assumptions to account for inventory holding time when determining the maximum service life for a TCI:
      1. If the shelf life is greater than the service life, the maximum service life for the TCI is the service life.
      2. If the shelf life equals the service life, the maximum service life for the TCI is the shelf life minus the point estimate of 21-months (1.75 years) inventory holding time.

   c. To account for service life that may be lost when a part is replaced early, we interviewed maintenance schedulers, egress personnel, and munitions supply personnel, and determined the remaining service life of a removed part varied between 0 and 0.5 years (0 – 6 months). Therefore, we used 0.25 years* (3-months) as the point estimate.

* With the possibility of inventory holding times ranging from 6 – 36 months and the remaining service life after TCI replacement ranging from 0 – 6 months, the parts cost reflected in Table 2 could be significantly effected. Therefore, we performed a sensitivity analysis to reflect how the variance in inventory holding times and remaining service life could effect the parts cost for each of the proposals. (See the Sensitivity Analysis section below.)

The part-by-part breakdown is listed in Appendix B with Table 2 (below) providing a summary of the estimated annual parts cost and man-hours per aircraft.

| | Current | 12-Month | 30-Month | 36-Month* |
|---|---|---|---|---|
| **Parts Cost reflecting service life change (delta)** | $6,731.90<br>N/A | $6,997.45<br>**(+$265.56)** | $8,026.96<br>**(+$1,295.06)** | $8,173.39<br>**(+$1,441.49)** |
| Part Replacement Man-hours reflecting service life change (delta) | 36.62<br>N/A | 38.41<br>(+1.79) | 39.86<br>(+3.24) | 51.17<br>(+14.55) |
| Seat Removal Man-hours reflecting maintenance proposal changes (delta) | 33.00<br>N/A | 33.00<br>(0.00) | 6.60<br>(-26.40) | 5.50<br>(-27.50) |
| **Total Man-hours (delta)** | 69.62<br>N/A | 71.41<br>**(+1.79)** | 46.46<br>**(-23.16)** | 56.67<br>**(-12.95)** |

**Table 2 - Annual Parts Replacement Cost and Man-hours per Aircraft**

* The reason for the 36-month cycle being more expensive, even though parts are being replaced less frequently in comparison to the 30-month cycle, is due to the total amount of service life lost. We used the maximum service life that could be lost in the analysis, which theoretically is 36-months under the 36-month maintenance cycle and 30-months under the 30-month maintenance cycle.

## SENSITIVITY ANALYSIS

The results reported in Table 2 used point estimates to show the effects of the various policies in terms of increased cost and reduced man-hours. This section obtains more robust estimates of these effects by taking into account the variability in the system.

Due to the range of their possible values, we converted the inventory holding time and the remaining service life of a removed part to random variables. Using these random variables, 5,000 iterations of a Monte Carlo Simulation were accomplished in order to investigate the effects of variance on the previously reported results of the analysis (Table 2). For this sensitivity analysis, the choice of random variables to use in modeling inventory holding time was based on information from the ALC and historical data from several units. ALC noted that inventory holding times can range between 0.5 and 3 years (6 – 36 months). The point estimate for average inventory holding time of 1.75 years (21 months) used in paragraph 3.b.2, was replaced with a Beta distributed random variable, derived from actual sample data from Langley, Seymour-Johnson, and Eglin AFBs.

As a result of interviews with maintenance schedulers, egress personnel, and munitions supply personnel, it was determined that the remaining service life of a removed part varied between 0 and 0.5 years (0 – 6 months). In this sensitivity analysis, a uniform distributed random variable replaces

the 0.25 year point estimate used previously (paragraph 3.c). This distribution assumes that it is equally likely for the remaining service life of any removed part to be anywhere between 0 and 0.5 years. This is based on the actual policies in place: schedulers are using the TCI expiration dates to forecast 6-months in advance, and therefore any given part can be replaced 0 to 6 months before its

actual expiration date. Table 3 illustrates the results of the sensitivity analysis in terms of the possible range in parts cost and maintenance man-hours, per aircraft, per year. The table reports the minimum, maximum, and average results of the 5,000 iterations of the simulation. The man-hour figures in Table 3 reflect an increase (+) or decrease (-) from man-hours under current procedures.

| | **Minimum** | **Average** | **Maximum** |
|---|---|---|---|
| Parts Cost Range 12-Month Proposal | $134.62 | $248.87 | $375.95 |
| Parts Cost Range 30-Month Proposal | $505.29 | $1238.40 | $2131.40 |
| Parts Cost Range 36-Month Proposal | $618.08 | $1523.00 | $2606.10 |
| Overall Man-hour Impact 12-Month Proposal | +0.70 hrs. | +1.65 hrs. | +3.23 hrs. |
| Overall Man-hour Impact 30-Month Proposal | -24.07 hrs. | -18.27 hrs. | -8.20 hrs. |
| Overall Man-hour Impact 36-Month Proposal | -25.11 hrs. | -16.47 hrs. | -9.43 hrs. |

**Table 3 Range of Annual Part Replacement Cost and Man-hours**

## BENEFITS

As indicated, each of the three policy proposals has different costs when compared to the current policies and procedures. However, the following intangible benefits may outweigh the costs incurred:

1. More efficient deployment preparation for Air Expeditionary Force operations (i.e. a reduction in the number of aircraft that will require off-schedule egress TCI maintenance).
2. Every seat removal that is eliminated represents one less chance to cause accidental damage or additional wear and tear to the aircraft itself or other systems located in a cramped cockpit. (See example in Appendix D). Note: The reduced damage risk to other systems is a very significant benefit. However, there are too many unknown variables to accurately quantify the reduction in probability of collateral damage and its affect on aircraft availability.
3. A seat can only be removed after an aircraft has been taken away from the flight line and extensive pre-removal preparations have been made. If the requirement to remove seats is reduced, (consolidating egress TCI maintenance actions) the associated requirement to remove an aircraft from the flight line is also reduced, leading to improved aircraft availability for other maintenance or operational use.

4. Maintenance-free windows for egress TCIs for the duration of an AEF deployment.
5. The ACES II seat inspection due date would be used for tracking purposes, eliminating tracking numerous individual item due dates.
6. More predictable maintenance cycles will enable units/ALCs to better forecast for parts requirements.

# CHAPTER 3

# IMPLEMENTATION

**ISSUES:**

In order for the 36-month maintenance cycle, the 30-month maintenance cycle, or the 12-month "look-out" policy to be implemented, the following areas need to be addressed:

1. Policy changes to:
   AFI 21-202 (and MAJCOM Instructions)
   AFI 21-101 (and MAJCOM Instructions)
   AFI 21-112 (and MAJCOM Instructions)
   T.O. 00-20-9
   T.O. 00-20-1
   T.O. 11A and 11P series

2. Forecasting policies have always plagued the TCI system at all levels and many studies/audits have attempted to remedy this. Per ALC Item Manager, only 60 to 75% of the annual forecasting requirements from units is reported to the ALC. Accurate forecasting is imperative in order for either the 36-month or 30-month maintenance cycles to work. Therefore, current forecasting policies and procedures will need to be changed.

3. Additional funding will be needed for additional parts, disposal costs, and transportation costs.

4. Possibility of being issued a part with insufficient shelf/service time to make it to the next 36-month or 30-month cycle is a concern. During our Sensitivity Analysis, we ran into instances where a part with a 60-month shelf/service life remained "on-the-shelf" for 36-months before being issued. At this point, the part only had 24-month shelf/service life remaining, causing the part to fall short of the next 36-month or 30-month maintenance cycle.

5. There is the possibility of parts failing an acceptance test. Production contracts are geared for items/parts to be built/purchased in "lots". A select percentage of the items/parts are tested to see if they "fire as advertised". When parts fail this test, production often falls behind and could throw off a 36-month or 30-month maintenance cycles.

**AREAS FOR FURTHER STUDY:**

1. Reconciliation of FEDLOG with CAS: The FEDLOG and CAS systems do not reflect the same information. CAS is inconsistent with linkages between the NSNs—doesn't link every NSN to other suitable substitute NSNs. FEDLOG will show all NSNs that are suitable substitutes for each item.

2. Possibility of direct vendor delivery to units: Currently, parts go to Hill AFB and remain there, using up shelf life, until they are issued to a unit. Direct vendor shipment coupled with increased accuracy in parts forecasting (a projected benefit of predictable maintenance cycles) may benefit the overall process by further reducing the inventory holding times at the depots. By reducing the inventory holding time, the amount of useable shelf life for the parts increases, which in-turn will offset the increased parts costs associated with the 30-month and 36-month maintenance cycles. (NOTE: Currently, direct vendor shipment is occasionally done. However, in addition to the added expenses incurred, it is a difficult process for the item manager and vendors.)

3. Establish the use of an automated tracking program for maintenance inspections: Currently, three bases are using an automated program that tracks their inspections. The program is updated weekly and kept on the LAN, enabling workcenters to quickly review upcoming inspections. By utilizing this program, the wing and squadron schedulers are saving an average of 40 man-hours per week that were previously spent tracking inspections manually using a Planning Requirements Listing from CAMS.

# CHAPTER 4

# CONCLUSIONS AND RECOMMENDATIONS

## CONCLUSIONS

Based upon our research and analysis, we concluded that the current egress TCI policies and procedures for the F-15D/E aircraft are working, as evidenced by the proven ability of units to deploy and sustain operations. However, due to the unique challenges and requirements that an AEF presents, current policies and procedures need to be adjusted accordingly to better meet the AEF taskings. Making adjustments to the current policies and procedures doesn't come without cost and although there is an increase in parts cost for both the proposed 36-month or 30-month maintenance cycles and the 12-month "look-out" policy, the intangible benefits gained may outweigh the increase in parts cost:

1. More efficient deployment preparation for expeditionary operations (i.e. a reduction in the number of aircraft requiring off-schedule egress TCI maintenance).
2. Fewer seat removals result in reduced risk of accidental or additional wear and tear on the aircraft or associated systems (see Appendix D).
3. Reduction in maintenance man-hours and possible aircraft downtime (increased aircraft availability) due to consolidation of egress TCI maintenance actions.
4. Maintenance-free windows for egress TCI maintenance for the duration of an AEF deployment.
5. The ACES II seat inspection due date would be used for tracking purposes, eliminating tracking numerous individual item due dates.
6. More predictable maintenance cycles will enable units and the Air Logistic Centers (ALC) to better forecast for parts requirements.

## RECOMMENDATIONS:

### SHORT TERM:

1. Implement a 12-month "look-out" policy for F-15D/E egress TCIs. Incorporate previously recommended Technical Order (T.O.) changes, AF XO/IL Offsite Action Item #8, 25 August 1997, which identified/proposed time interval changes to current policies (see Appendix A). (OPR: HQ USAF/ILM)

### LONG TERM:

1. Consider establishing a transition team to implement either a 36-month or 30-month maintenance cycle for F-15D/E egress TCIs. **(OPR: HQ USAF/ILM)**

2. Explore the feasibility of adopting the same maintenance cycle for other aircraft with the ACES II seat. **(OPR: HQ USAF/ILM)**

3. Incorporate a change/capability to track egress TCIs in the Integrated Maintenance Data System (IMDS) based on the ACESS II seat inspection due date in addition to the date of installation (DOI) and date of manufacture (DOM) of each TCI. **(OPRs: HQ USAF/ILM and IMDS/SPO)**

**DISTRIBUTION:** Refer to attached Standard Form 298.

# APPENDIX A

## RECOMMENDED T.O. CHANGES

Listed are the recommended changes. The current reading of the T.O. or AFI will be listed first followed by the recommended changes (all recommended changes to the T.O. or AFI are underlined).

1. T.O. 00-20-1, page 4-8, para 4-12.8 NOTE currently reads:

NOTE
Requests for CAD/PAD shelf/service life extensions should be forwarded for action to USAF ACP, Hill AFB UT/MMW with an information copy to the appropriate aircraft SM, on a case-by-case basis. The following information will be included: Aircraft serial number; date CAD/PAD item was installed; aircraft grounding date; CAD/PAD DOM; lot number; and status of requisition for replacement part. The required engineering analysis will be accomplished by the OO-ALC/ LIW and a flight/grounding recommendation made to the aircraft SM. The aircraft SM will make the final determination on aircraft status. Requests for ALSE items shelf/service life extensions should be forwarded to HSC/YAD, 8107 13th St, Brooks AFB, TX 78235-5238 through the appropriate Major Command focal point. The Life Support System Manager (HSC/YA) will consider shelf/service life extensions based upon item application and engineering technical analysis IAW AFI 11-301. The intent is to preclude unnecessary aircraft grounding.

Recommendation:

NOTE
Requests for CAD/PAD shelf/service life extensions should be forwarded for action to OO-ALC/LIW, Hill AFB UT with an information copy to the appropriate aircraft SPM, on a case-by-case basis. The following information will be included: Aircraft serial number; date CAD/PAD item was installed; aircraft grounding date; CAD/PAD DOM; lot number; document number of requisition for replacement parts and reason for extension request (i.e. aircraft is vulnerable for AEF deployment, aircraft is scheduled for retirement, replacements parts are unavailable, etc.). The required engineering analysis will be accomplished by the OO-ALC/ LIW and a flight/grounding recommendation made to the aircraft SM. The aircraft SM will make the final determination on aircraft status. Requests for ALSE items shelf/service life extensions should be forwarded to HSC/YAD, 8107 13th St, Brooks AFB, TX 78235-5238 through the appropriate Major Command focal point. The Life Support System Manager (HSC/YA) will consider shelf/service life extensions based upon item application and engineering technical analysis IAW AFI 11-301. The intent is to preclude unnecessary aircraft grounding.

2. TO 11A-1-10, page 3-8, para 3-11(e) NOTE currently reads:

NOTE:
Aircraft egress items removed for time change in accordance with policies set forth in T.O. 00-20-1 will be retained/reported in the actual condition code dependent upon remaining shelf/service life. When shelf/service life is within nine months of expiration, the items will be placed in applicable condition code, depending on whether or not the item is repairable at depot.

Recommendation:

NOTE
Aircraft egress items removed for time change in accordance with policies set forth in T.O. 00-20-1 will be retained/reported in the actual condition code dependent upon remaining shelf/service life. When the shelf/service life of an item is within nine months of expiration, the item will be placed in condition code "F" or "J" and will not be reissued unless directed by ALC.

3. AFI 21-101, page 18, para 2.12.1 currently reads:

Order all items requiring time change up to 60 days before the required month. Order munitions items 60 days before the beginning of the month required. Forward only AF Forms 2005, **Issue/Turn-In Request**, to the munitions supply point. Include the forecast time change date. Use SBSS procedures if available.

Recommendation:

Order all items requiring time change up to 60 days before the required month. Order munitions items 60 days before the beginning of the month required. (Exception: To ensure a unit that is vulnerable for an AEF deployment is fully operational during its vulnerability window, all CAD/PAD items with expiration dates falling within this window must be ordered in sufficient time to allow replacement prior to the first day of the vulnerability window). Forward only AF Forms 2005, **Issue/Turn-In Request**, to the munitions supply point. Include the forecast time change date. Use SBSS procedures if available.

4. AFI 21-201, page 17, par. 2.5.4. (NOTE) currently reads:

***NOTE:*** Retain or report the actual condition code dependent upon remaining shelf and/or service life of aircraft egress items removed for time change according to policies TO 00-20-1, *Preventive Maintenance Program, General Requirements and Procedures.* When shelf and/or service life is within 6 months of expiration, place the items in condition code J or F (if the item is repairable at depot).

Recommendation:

***NOTE:*** Retain or report the actual condition code dependent upon remaining shelf and/or service life of aircraft egress items removed for time change according to policies TO 00-20-1, *Preventive Maintenance Program, General Requirements and Procedures.* When shelf and/or service life is within 9 months of expiration, place the items in condition code "J " or "F" and do not reissue unless directed by ALC.

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# APPENDIX B

## EGRESS TCI LISTING

*The following listings contain the Egress TCIs for the F-15D/E aircraft and is the base used for meeting Objectives 1 and 2.*

| | | | | | | | Current | | 12 "look-out" | | 36 Schedule | | 30 Schedule | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P | NOUN/NSN | QTY | Life | Cost | Time | Crew | $$ | MH | $$ | MH | $$ | MH | $$ | MH |
| | EXT CNPY JETT INIT | | | | | | | | | | | | | |
| 0.00 | NSN 1377-00-299-1506 | 1 | 9.25 | 636.54 | 1.25 | 2 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1.00 | NSN 1377-01-063-2198 | 1 | 9.25 | 652.00 | 1.25 | 2 | 72.44 | 0.28 | 74.51 | 0.29 | 72.44 | 0.28 | 86.93 | 0.33 |
| 0.00 | NSN 1377-01-166-4264 | 1 | 5.25 | 980.00 | 1.25 | 2 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | ROCKET CATAPULT | | | | | | | | | | | | | |
| 0.33 | NSN 1377-00-262-1679 | 2 | 6.25 | 3830.36 | 1.00 | 2 | 425.60 | 0.22 | 444.10 | 0.23 | 425.60 | 0.22 | 510.71 | 0.27 |
| 0.33 | NSN 1377-01-359-3194 | 2 | 7.25 | 5000.00 | 1.00 | 2 | 476.19 | 0.19 | 493.83 | 0.20 | 555.56 | 0.22 | 666.67 | 0.27 |
| 0.33 | NSN 1377-01-169-7797 | 2 | 7.25 | 4210.86 | 1.00 | 2 | 401.03 | 0.19 | 415.89 | 0.20 | 467.87 | 0.22 | 561.45 | 0.27 |
| | INT. CNPY JETT INIT | | | | | | | | | | | | | |
| 1.00 | NSN 1377-00-322-0078 | 2 | 6.25 | 1245.00 | 1.50 | 2 | 415.00 | 1.00 | 433.04 | 1.04 | 415.00 | 1.00 | 498.00 | 1.20 |
| 0.00 | NSN 1377-01-166-4266 | 2 | 4.25 | 1300.00 | 1.50 | 2 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | CANOPY RMVR CART | | | | | | | | | | | | | |
| 1.00 | NSN 1377-01-202-9195 | 1 | 7 | 1711.86 | 3.00 | 2 | 253.61 | 0.89 | 263.36 | 0.92 | 285.31 | 1.00 | 342.37 | 1.20 |
| | CANOPY ACT INIT | | | | | | | | | | | | | |
| 1.00 | NSN 1377-00-299-1512 | 1 | 8.25 | 915.00 | 0.75 | 2 | 114.38 | 0.19 | 118.06 | 0.19 | 152.50 | 0.25 | 122.00 | 0.20 |
| 0.00 | NSN 1377-01-166-4265 | 1 | 5.25 | 897.00 | 0.75 | 2 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | GAS/SMDC INIT | | | | | | | | | | | | | |
| 0.00 | NSN 1377-01-375-8919 | 3 | 5.5 | 317.28 | 2.00 | 2 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | NSN 1377-01-203-1961 | 3 | 7.25 | 536.36 | 2.00 | 2 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.50 | NSN 1377-01-244-9273 | 3 | 6 | 400.67 | 2.00 | 2 | 104.52 | 1.04 | 109.27 | 1.09 | 100.17 | 1.00 | 120.20 | 1.20 |
| 0.00 | NSN 1377-00-299-1500 | 3 | 8.25 | 125.15 | 2.00 | 2 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | NSN 1377-01-166-4263 | 3 | 6.25 | 315.00 | 2.00 | 2 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.50 | NSN 1377-01-262-0521 | 3 | 3.25 | 353.00 | 2.00 | 2 | 176.50 | 2.00 | 192.55 | 2.18 | 176.50 | 2.00 | 211.80 | 2.40 |
| | SMDC/GAS INIT | | | | | | | | | | | | | |
| 0.00 | NSN 1377-01-203-1960 | 4 | 5.25 | 458.35 | 2.00 | 2 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.33 | NSN 1377-01-165-2080 | 4 | 5.25 | 830.00 | 2.00 | 2 | 221.33 | 1.07 | 232.98 | 1.12 | 368.89 | 1.78 | 221.33 | 1.07 |
| 0.00 | NSN 1377-00-299-1511 | 4 | 8.25 | 462.91 | 2.00 | 2 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | NSN 1377-01-287-4174 | 4 | 3.25 | 458.35 | 2.00 | 2 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.33 | NSN 1377-01-269-8061 | 4 | 5.33 | 375.95 | 2.00 | 2 | 98.67 | 1.05 | 103.78 | 1.10 | 167.09 | 1.78 | 100.25 | 1.07 |
| 0.33 | NSN 1377-01-234-8510 | 4 | 5.33 | 375.95 | 2.00 | 2 | 98.67 | 1.05 | 103.78 | 1.10 | 167.09 | 1.78 | 100.25 | 1.07 |

**TABLE B-1 EGRESS TCIs ON THE F-15D/E AIRCRAFT**

# APPENDIX B

## EGRESS TCI LISTING (cont.)

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | ONE-WAY TRANSFER INIT NSN 1377-00-299-1515 | 3 | 8.25 | 319.30 | 6.00 | 3 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | NSN 1377-01-167-6621 | 3 | 5.25 | 193.64 | 6.00 | 3 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1.00 | NSN 1377-01-220-3746 | 3 | 5.25 | 173.60 | 6.00 | 3 | 104.16 | 10.80 | 109.64 | 11.37 | 173.60 | 18.00 | 104.16 | 10.80 |
| 1.00 | .40 TIME DELAY INIT NSN 1377-01-203-8651 | 2 | 5.25 | 514.00 | 0.50 | 2 | 205.60 | 0.40 | 216.42 | 0.42 | 342.67 | 0.67 | 205.60 | 0.40 |
| 0.00 | NSN 1377-00-299-1516 | 2 | 5.25 | 1447.15 | 0.50 | 2 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1.00 | 1.5 TIME DELAY INIT NSN 1377-01-318-7697 | 1 | 3.25 | 311.06 | 2.00 | 2 | 103.69 | 1.33 | 113.11 | 1.45 | 103.69 | 1.33 | 124.42 | 1.60 |
| 1.00 | 2.0 TIME DELAY INIT NSN 1377-01-318-7696 | 1 | 3.25 | 311.06 | 2.00 | 2 | 103.69 | 1.33 | 113.11 | 1.45 | 103.69 | 1.33 | 124.42 | 1.60 |
| 1.00 | EJECT SEQ. SELECTOR NSN 1377-00-349-3943 | 1 | 9 | 1752.00 | 3.00 | 2 | 200.23 | 0.69 | 206.12 | 0.71 | 194.67 | 0.67 | 233.60 | 0.80 |
| 1.00 | GAS/GAS INIT NSN 1377-00-238-0552 | 3 | 11.3 | 571.53 | 2.00 | 2 | 155.87 | 1.09 | 159.50 | 1.12 | 190.51 | 1.33 | 171.46 | 1.20 |

**TABLE B-1 EGRESS TCIs ON THE F-15D/E AIRCRAFT (cont.)**

# APPENDIX B

## EGRESS TCI LISTING (cont.)

| | | | | | | | Current | | 12 "look-out" | | 36 Schedule | | 30 Schedule | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P | NOUN/NSN | QTY | Life | Cost | Time | Crew | $$ | MH | $$ | MH | $$ | MH | $$ | MH |
| 1.00 | JAU-8 EJECTION INIT NSN 1377-00-403-4827 | 4 | 8.75 | 269.93 | 0.75 | 2 | 127.03 | 0.71 | 130.88 | 0.73 | 179.95 | 1.00 | 143.96 | 0.80 |
| 1.00 | INERTIA REEL GAS GEN NSN 1377-01-166-4261 | 2 | 5.25 | 230.72 | 1.50 | 2 | 92.29 | 1.20 | 97.15 | 1.26 | 153.81 | 2.00 | 92.29 | 1.20 |
| 1.00 | DROGUE GUN CART NSN 1377-01-052-8208 | 2 | 8.25 | 174.27 | 1.00 | 2 | 43.57 | 0.50 | 44.97 | 0.52 | 58.09 | 0.67 | 46.47 | 0.53 |
| 0.00 | NSN 1377-01-322-0071ES | 2 | 5.25 | 211.66 | 1.00 | 2 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1.00 | MORTAR CART NSN 1377-01-052-8207 | 4 | 7.75 | 226.45 | 1.00 | 2 | 120.77 | 1.07 | 124.94 | 1.10 | 150.97 | 1.33 | 120.77 | 1.07 |
| 0.00 | NSN 1377-01-322-6334 | 4 | 5.25 | 204.45 | 1.00 | 2 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1.00 | ENVIRONMENTAL SENSOR NSN 1680-01-100-6631 | 2 | 7.25 | 1824.99 | 0.50 | 2 | 521.43 | 0.29 | 540.74 | 0.30 | 608.33 | 0.33 | 730.00 | 0.40 |
| 1.00 | FLSC HOLDER ASSY NSN 1377-01-083-8459 | 4 | 5.75 | 208.06 | 1.00 | 2 | 151.32 | 1.45 | 158.52 | 1.52 | 277.41 | 2.67 | 166.45 | 1.60 |
| 0.00 | NSN 1377-01-234-0706 | 4 | 5.25 | 272.00 | 1.00 | 2 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1.00 | RECOVERY SEQUENCER NSN 1680-01-053-9320 | 2 | 14.25 | 5144.19 | 8.00 | 3 | 734.88 | 3.43 | 748.25 | 3.49 | 857.37 | 4.00 | 823.07 | 3.84 |
| 1.00 | HARNESS REL CART NSN 1377-01-052-8206 | 2 | 5.25 | 304.88 | 0.75 | 2 | 121.95 | 0.60 | 128.37 | 0.63 | 203.25 | 1.00 | 121.95 | 0.60 |
| 0.00 | NSN 1377-01-368-5411 | 2 | 5.25 | 221.45 | 0.75 | 2 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1.00 | THERMAL POWER SUPPLY NSN 6130-01-312-3511 | 2 | 8.5 | 774.60 | 1.00 | 2 | 187.78 | 0.48 | 193.65 | 0.50 | 258.20 | 0.67 | 206.56 | 0.53 |
| 0.00 | VERNIER RCKT MOTOR NSN 1377-01-318-1830 | 2 | 9.25 | 1798.94 | 2.00 | 2 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | NSN 1377-00-119-2033 | 2 | 9.25 | 426.00 | 2.00 | 2 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | NSN 1377-01-053-0586 | 2 | 9.25 | 1434.79 | 2.00 | 2 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1.00 | NSN 1377-01-255-1650 | 2 | 9.25 | 2742.67 | 2.00 | 2 | 609.48 | 0.89 | 626.90 | 0.91 | 609.48 | 0.89 | 731.38 | 1.07 |
| 1.00 | GYRO GAS GEN NSN 1377-01-053-0537 | 2 | 5.25 | 195.70 | 1.00 | 2 | 78.28 | 0.80 | 82.40 | 0.84 | 130.47 | 1.33 | 78.28 | 0.80 |
| 0.00 | NSN 1377-01-319-3847 | 2 | 5.25 | 190.00 | 1.00 | 2 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.00 | STAPAC (7 sls) NSN 1680-01-004-5337 | 2 | 16.25 | 3742.93 | 12.00 | 3 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.33 | TRAJ DIV ROCKET NSN 1377-01-053-0587 | 2 | 15 | 870.35 | 1.00 | 2 | 39.34 | 0.09 | 40.02 | 0.09 | 38.68 | 0.09 | 38.68 | 0.09 |
| 0.33 | NSN 1377-01-256-1971 | 2 | 12 | 1581.05 | 1.00 | 2 | 89.70 | 0.11 | 91.66 | 0.12 | 87.84 | 0.11 | 105.40 | 0.13 |
| 0.33 | NSN 1377-01-053-0587 | 2 | 7.25 | 870.35 | 1.00 | 2 | 82.89 | 0.19 | 85.96 | 0.20 | 96.71 | 0.22 | 116.05 | 0.27 |

**TABLE B-2 EGRESS TCIs ON THE ACES II SEAT**

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# APPENDIX C
## FORMULAS

**PARTS COST AND REPLACEMENT MAN-HOURS**

$$PC_i = \sum_j \left[ P_{i,j} * Q_i * \left( \frac{C_{i,j}}{L_{i,j}} \right) \right]$$ = EST. WEIGHTED ANNUAL PARTS COST (associated with any TCI($i$))

$$MH_i = \sum_j \left[ P_{i,j} * Q_i * \left( \frac{T_i * S_i}{L_{i,j}} \right) \right]$$ = EST. WEIGHTED ANNUAL PART REPLACEMENT MAN-HOURS (associated with any TCI ($i$))

where: $C_{i,j}$ – the cost of the TCI $i$ that is manufactured by vendor $j$,
$L_{i,j}$ – the service life of the TCI $i$ that is manufactured by vendor $j$,
$P_{i,j}$ – the probability that a demand for TCI $i$ will be satisfied with a part manufactured by vendor $j$,
$Q_i$ – the quantity of part $i$ required per aircraft,
$T_i$ – the time required to replace part $i$, and
$S_i$ – the crew size required to replace part $i$.

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# APPENDIX D

Below is a section from a report which depicts what can happen when an ejection seat is removed. While this sort of mishap does happen, it is rare. However, the fact remains, anytime a seat is removed, there is a chance for accidental damage in varying degree. By consolidating egress scheduled TCI maintenance, the number of seat removals is kept to a minimum, thus decreasing the chances for mishaps.

DURING ROUTINE MAINTENANCE ON AN F-16D, FLIGHT LINE PERSONNEL DISCOVERED A VELCRO STRAP MISSING FROM THE FRONT COCKPIT MAP CASE. WHILE SEARCHING FOR THE STRAP, THEY DISCOVERED A LOOSE BOLT UNDER THE FRONT COCKPIT SEAT. AFTER RESEARCHING THE PART NUMBER, MAINTENANCE PERSONNEL DETERMINED THAT THE BOLT MAY HAVE ORIGINATED FROM THE EJECTION SEAT RAILS. EGRESS PERSONNEL WERE DISPATCHED AND REMOVED THE FRONT SEAT TO CHECK THE RAILS AND FOUND ALL THE BOLTS IN PLACE. THEY ALSO REMOVED THE AFT COCKPIT SEAT AND AGAIN FOUND ALL BOLTS IN PLACE. DURING SEAT REMOVAL PROCEDURES FOR THE AFT SEAT, THE LEFT, AFT CANOPY SEAL CHANNEL WAS DAMAGED. SHEET METAL PERSONNEL WERE CALLED TO REPAIR THE CHANNEL. DURING REMOVAL OF THE DAMAGED PORTION OF THE CHANNEL, SHEET METAL PERSONNEL DAMAGED A RETAINER BRACKET REQUIRED TO MOUNT THE CANOPY SEAL CHANNEL. BECAUSE NO WRITTEN INSTRUCTIONS WERE AVAILABLE TO REPAIR THE BRACKET, SHEET METAL PERSONNEL DESIGNED AN "L" ANGLE DOUBLER REPAIR AND SUBMITTED THEIR PROPOSAL TO DEPOT (ALC OGDEN, UTAH) FOR FURTHER GUIDANCE. THIS REPAIR REQUIRED DRILLING THROUGH THE AFT COCKPIT UPPER BULKHEAD AT STATION 243.00. DEPOT PERSONNEL AGREED WITH THE PROPOSAL AND RECOMMENDED THE USE OF 2024-T6 ALUMINUM INSTEAD OF 17-4 PH STAINLESS STEEL TO CONSTRUCT THE BRACKET. AFTER REVIEWING T.O. 1 F-1 6CJ-3-1, SECTION 3, THE SHEET METAL TECHNICIANS WERE UNSURE OF WHAT WAS BEHIND THE BULKHEAD AND ASKED THE FLIGHT LINE SUPERVISION FOR ASSISTANCE. DUE TO MISCOMMUNICATION, THE FLIGHTLINE EXPEDITER ADVISED THEM THAT THERE WAS NO DANGER IN DRILLING OUT THE RIVETS TO REMOVE THE DAMAGED CANOPY SEAL CHANNEL. THE SHEET METAL TECHNICIANS UNDERSTOOD THIS TO MEAN THAT IT WAS SAFE TO DRILL THROUGH THE BOTH THE CANOPY SILL AND THE BULKHEAD. ADDITIONALLY, DEPOT PERSONNEL DID NOT OFFER ANY ADVICE ABOUT NOT DRILLING THROUGH THE AFT BULKHEAD IN THEIR RESOPNSE TO THE RECOMMENDATION FOR REPAIR. WHEN THE SHEET METAL TECHNICIAN DRILLED THROUGH THE BULKHEAD, FUEL STREAMED OUT THROUGH THE HOLE, SPILLING JP-8 INTO THE AFT COCKPIT AND WETTING THE LEFT CONSOL AND FLOOR AREAS. HE IMMEDIATELY STOPPED THE STREAM BY PLACING HIS THUMB OVER THE HOLE. THIS ACTION FORCED THE FUEL TO EXIT AT THE F-1 CAVITY DRAIN PORT. APPROXIMATELY ONE TO ONE AND ONE-HALF PINTS OF JP-8 SPILLED INTO THE COCKPIT AREA (LEFT CONSOLE AND FLOOR). A PRELIMINARY INVESTIGATION REVEALED THAT NEITHER THE 1 F-1 6CJ-3-1 NOR THE F-16CJ-3-3 PROVIDE ADEQUATE INFORMATION ABOUT THE EXACT LOCATION OF THE FORWARD SIDE OF THE F-1 FUEL BLADDER ON THE D-MODEL F-16.

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# APPENDIX E

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| | | | | | |
|---|---|---|---|---|---|
| SMSgt | Wayne | Wedge | HQ ACC/LGMS | Langley AFB | Accessories/Egress Command Prog Mgr |
| SMSgt | Scott | Acre | HQ ACC/LGMS | Langley AFB | Accessories/Egress Command Prog Mgr |
| MSgt | Michael | Young | 4 EMS | Seymour Johnson AFB | Munitions Inspection |
| MSgt | David | Kelly | 1 CRS | Langley AFB | Egress Element Chief |
| MSgt | Kenneth | Morgan | 33 OSS | Eglin AFB | NCOIC Plans and Scheduling |
| MSgt | Robert | Cox | 33 MXS | Eglin AFB | Supt Materiel Section |
| TSgt | Philip | Bonton | 33 MXS | Eglin AFB | Egress Section Chief |
| TSgt | Craig | Imler | 33 MXS | Eglin AFB | Munitions Operations Supply (AFK) |
| TSgt | Brian | Smeltzer | HQ SSG | Gunter Annex | Strategy Functional |
| TSgt | Brian | Brown | 335 FS | Seymour Johnson | NCOIC Plans and Scheduling |
| SSgt | Patrick | Collins | 4 EMS | Seymour Johnson AFB | TCI Monitor |
| SSgt | Tom | Clemons | 33 OSS | Eglin AFB | TCI Scheduler |
| SSgt | Andre | Oliver | 60 FS | Eglin AFB | NCOIC Squadron Plans Scheduling and |
| SSgt | Ronald | Billings | 33 MXS | Eglin AFB | Egress Specialist/TCI Monitor |
| SSgt | Jacqueline | Portis | 27 FS | Langley AFB | NCOIC Plans and Scheduling |
| SSgt | John | Peoples | 1 EMS | Langley AFB | TCI Monitor Stock Control |
| SSgt | Clifford | Searcy | 58 FS | Eglin AFB | NCOIC Plans and Scheduling |
| SSgt | Ronald | Ellis Jr. | 4OSS | Seymour Johnson AFB | NCOIC Plans Scheduling and Documentation |
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**TABLE E-1 PERSONNEL INTERVIEWED/CONTACTED**